REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested in view of the foregoing amendments and discussion presented herein.

1. Rejection of Claims 1-33 under 35 U.S.C. § 103(a).

Claims 1-33 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of Gris (U.S. Patent No. 6,187,646) and Yamazaki (U.S. Patent No. 4,498,092).

Claims 1, 6, 11, 16, 21, 26 and 31. Claims 1, 6, 11, 16, 21, 26 and 31 are the pending independent claims in the instant application.

In support of the rejection, the Examiner takes the position that Gris teaches a first semiconductor material substantially vertical from substrate 1 including sidewall (corresponding to the lower portion thereof) and an upper surface (corresponding to the upper or top portion of the sidewall and to at least a portion of the upper surface of the first material. The Examiner also takes the position that the doping is taught by Gris and refers to Figs. 9-18, column 4 lines 4-37; column 5 line 60 to column 6 line 7, in Gris. The Examiner further asserts that the junction therebetween is inherent given the doping and materials employed in Gris as delineated and as evidenced by Yamazaki.

The Examiner also asserts that Yamazaki teaches the junction formation including PN, PI or NI junction where the first and second semiconductor regions are in contact with one another including when the first and second semiconductor regions have different or same conductivity type, different concentrations, and refers to the abstract in column 3, lines 47-64.

Based on the foregoing, the Examiner then concludes that it would have been obvious to one skilled in the art that the Gris structure would encompass the junction as evidenced by Yamazaki.

However, the Applicant has found a number of shortcomings with the obviousness rejection even as directed to the prior pending claims, and the amended claims further distinguish the present invention from the cited art. The following is the

Applicant's explanation of why the rejected claims are patentable over the cited art.

(1) **Different objects and operating principles.** First, the referenced U.S. Patents (No.4,498,092 to Yamazaki and No. 6,187,646 to Gris) cited by the Examiner cover different semiconductor devices. Specifically, the Yamazaki reference teaches a photodetector and the Gris reference teaches a capacitor. These different objects and operating principles are substantially different from one another and both different then the bipolar junctions and transistors taught by the instant application. Consequently, the purpose and principles of these inventions are not suited to the present invention.

(2) **No Suggestion, Motivation or Incentive within References.** There is no reasoning put forth in support of attempting the given combination of Gris and Yamazaki. Establishing a *Prima Facie* case of obviousness requires that a number of conditions be met. Referring to MPEP 706.02(j): Contents of a 35 U.S.C. 103 Rejection:

> "35 U.S.C. 103 authorizes a rejection where, to meet the claim, it is necessary to modify a single reference or to combine it with one or more other references. After indicating that the rejection is under 35 U.S.C. 103, the examiner should set forth in the Office action:
>
> (A) the relevant teachings of the prior art relied upon, preferably with reference to the relevant column or page number(s) and line number(s) where appropriate,
>
> (B) the difference or differences in the claim over the applied reference(s),
>
> (C) the proposed modification of the applied reference(s) necessary to arrive at the claimed subject matter, and
>
> (D) an explanation why one of ordinary skill in the art at the time the invention was made would have been motivated to make the proposed modification."

Nothing is brought forth as to the suitability of the combination, and Applicant is also unable to find any suggestion, motivation or incentive for the combination, except the teachings of the instant application itself.

(3) **Different structures not taught by references.** The instant application has different structural or functional elements in comparison to the cited references.

(a) _Gris does not describe structures suitable for bipolar junction devices_. In the rejection it is put forth that Gris (6,187,646) teaches two semiconductor materials 43/143 and 46/146 in the contact on their sidewalls and substantially vertical from the surface. However, material 43 of Gris is undoped polysilicon (or polycrystalline silicon) obtained by deposition while material 46 is heavily doped n-type polysilicon. Material 43 serves as an insulating spacer, for the isolation between the emitter and base regions, therefore material 43 is an isolation layer, not an active device layer, wherein no junction is formed. Material 46 is a transistor emitter (the same as n+ polysilicon layer within the instant application). Material 146 is also doped polysilicon (see column 6, lines 4-7). The contact between those two polysilicon layers cannot be used to form a conventionally operating bipolar transistor, which is in contrast to the device recited in Applicant claims. A junction according to the teachings of Gris would have an excessive leakage current and a high concentration of generation recombination centers, which is unacceptable for most bipolar transistor applications. It should be noted that the instant application (see paragraph [0050]) describes the resultant transistors as: *"Note also that this invention can be used in all of the applications of existing bipolar junction devices".*

Consequently, the junction described by Gris is not suited for the formation of pn, pnp, npn, np, ni, pi, pin junction and so forth with leakage currents acceptable for the operation of bipolar transistors.

(b) *Applicant's claims recite a single crystalline orientation.* The amended claims of the instant application are directed toward bipolar junction devices in single crystalline substrates (having a desired crystalline orientation), which is the case for the bulk of existing high-performance bipolar transistors. By contrast the materials recited by Gris, specifically those referenced as 43/143 and 46/146 are made of polycrystalline silicon, which is not suitable for processing *pn* and other types of bipolar junctions.

The first material in the amended claims are recited as *"having the same crystalline orientation as said substrate".* Of course, specification of any desired or specific crystal orientation is indicative of single crystalline semiconductor material.

Such can not be said of the materials of the relied-upon references of Gris and Yamazaki.

(c) *Applicant's claims recite a second material on sidewall and upper surface of the single crystalline first material.* This group of claims recites a second material on the upper surface and sidewalls of the first material, which is described as a semiconductor material with the same crystal orientation as the substrate. The relied upon references do not teach comparative structures.

(d) *Applicant's amended claims recite single crystalline structure about second material.* The amended claims describe that the second material is joined into, recited now as *"implanted or diffused into"*, the sidewall and upper surface of the single crystalline silicon of the first material. Wherein the structure about the second material remains in a single crystalline form and not of polysilicon.

(e) *Applicant's amended claims recite first material formed from substrate.*

Amended independent Claims 26 and 31, as well as dependent claims 95, 99, 103, further recite that the first material is not only of the same crystal orientation, but comprises a portion of the substrate after removal of substrate material leaving said hill formed. Therefore, the identical crystal orientation and crystal quality is provided to enhance device operation.

Neither of the relied-upon reference provide a similar structure. In the patent of Gris materials 43/143 and 46/146 are not even connected to the substrate, and certainly can not be said to have the same crystal orientation and quality as the substrate. In addition, materials 43/143 and 46/146 are deposited on the existing materials of the sample. In summary, it is not possible to built a device of the type claims in the instant application using materials 43/143 and 46/146.

(f) *Applicant's amended claims recite second material in corner of first material.*

Amended independent Claims 26 and 31, as well as new dependent claims 92, 96, 100, describe the corner relationship of the second material on the first material, hill. Specifically, the independent claims recite: *"a second material implanted or diffused into* *an upper portion of a first said sidewall and an adjoining portion of said upper surface of said first material*".

The new dependent claims further define the second material position as: "*wherein said second material is implanted or diffused into an upper portion of a first sidewall of said first material and an adjoining portion of said upper surface of said first material*".

The active junction region of Applicant's device is only at the top part of the sidewall, whereas the bottom part serves as the isolation region.

It is not possible to obtain such structure following the teaching of either Gris or Yamazaki. In the process as described in Gris's patent, the bottom part of material 43 cannot be isolated from the material 46. Also, n+ polysilicon described in the instant application is in contact only with a part of the sidewall from the top side, which is obtained by the etch-back process, where the active sidewall (i.e., the n-hill) is self protected. This aspect is also not taught or possible from the Gris structure teachings. By using etch-back process, both materials 43 and 46 would be removed, instead of only material 43.

(g) Applicant's amended claims recite additional structures. Amended independent Claims 21 and 31, as well as new dependent claims 93, 97, 101, 107, and 113, describe additional regions including a stop channel, isolation region and polysilicon regions adapted for receiving the contacts. These structures are not found in this same combination in the relied-upon references.

Accordingly, the structures of the relied-upon references can not be properly equated to those recited in pending independent Claims 1, 11, 16, 21, 26 and 31, and far less so in view of the claim amendments presented herein. Accordingly, Claims 1, 11, 16, 21, 26 and 31, as well as the claims which depend therefrom, are patentable over the cited art.

Claims 3-5, 13-15, 18-20 and 23-25. Dependent claims 3-5, 13-15, 18-20 and 23-25 describe types of junctions formed within the device recited in the base claim(s).

In view of the traversal of the obviousness rejection for the base independent claims, these claims should be considered *a fortiori* allowable.

Furthermore, these dependent claims provide additional grounds for patentability over their respective base claims, which is now described.

The Examiner rejected Claims 3-5, 13-15, 18-20 and 23-25 on the grounds that Yamazaki (4,498,092) teaches the junction formation including *pn*, *pi* or *ni* junctions. (It should be noted that the recitation of junction type remains but in some claims was consolidated into fewer claims). However, The junction in Yamazaki's patent are processed in semi-amorphous silicon (or polycrystalline, or nanocrystalline) and thus are not processed in single crystalline material as are those recited in the instant application. In addition, junctions formed according to the amended claims form from doping a single crystalline silicon by certain impurity by the processes of ion implantation or diffusion. The *n*, *p*, or *i* regions in Yamazaki's patent are processed by the deposition of the material in-situ doped by the impurity. Hence, *pn*, *pi*, *ni* junctions in Yamazaki's patent correspond to the boundaries between the deposited layers, whereas in Applicant's claimed invention the junctions are formed within one single crystalline material, ensuring low-leakage junctions.

Additionally, Yamazaki's structure is processed on the substrate, which is not semiconductor, (e.g., ceramics, stainless steel or glass), whereas claims of the present invention are directed at semiconductor substrates, such as silicon, SOI, and so forth.

Consequently, the material of these dependent claims can not be properly equated with the teachings of Yamazaki. Applicant respectfully requests that the rejection of the dependent claims be withdrawn.

Therefore, the relied-upon combination of references does not teach or render obvious the claimed invention, and the Applicant respectfully requests that the rejection of independent Claims 1, 11, 16, 21, 26 and 31, and the claims which depend therefrom, be withdrawn.

2. Amendment of Specification.

The Applicant has amended the specification to improve clarity, and apologizes for any inconvenience which this may have caused the Examiner."

The proposed specification amendment provides additional clarity to those who are not familiar with aspects of semiconductor crystal materials. Specifically, the industry standard term "single crystal materials" for referring to materials having a fixed crystalline orientation, such as 110, 111, and so forth as found throughout the specification. One of ordinary skill in the art recognizes that one would only specify a crystal direction indicia for a single crystalline material. There is no meaning of a crystal direction with regard to polycrystalline material, because in a poly material there is no single crystal direction for the region which could be specified.

To provide support that the term "single crystalline" is synonymous with indicating a crystal orientation, a search of the conjunction ("111" AND "single crystalline silicon") on the USPTO patent database web site yielded 596 patents having both terms. For example in patent 6,924,506 entitled: "*Semiconductor device having channel formation region comprising silicon and containing a group IV element*" the following statements are made:

> "Further, if the thickness of the film is enough large, the columnar crystals grow in such a manner that the (110) direction aligns vertically to the substrate surface. This crystallization can be observed on the entire surface of the substrate. ...crystallization was also confirmed in the adjacent area in which the lead was not directly added, and a peculiar crystal growth in which needle or pillar shape crystals grew substantially in parallel to the substrate so that the (*111*) plane was aligned vertically to the substrate was also observed in this area."

3. Amendment of Claims 1, 6, 11, 16, 21-22, 24-26 and 28-33.

The claims were amended to recite the invention with greater particularity.

Claims 1, 6, 11, 16, 21, 26 and 31. Each of the independent claims has been amended to clarify or further recite the following elements: (a) the device is a "bipolar" junction device (support can be found in the Title; paragraph [0010]; etc.); (b) the substrate is "*of semiconductor material having a desired crystalline orientation*", which of course is a single crystalline material (support can be found in paragraphs [0045] - [0046], [0049] - [0050], etc.); (c) the first material is "*semiconductor*" and is configured "*to form a hill having the same crystalline orientation as said substrate*" the text describing it being formed from the substrate material (support can be found in paragraphs [0031]; and (d) the second material can perhaps be more appropriately described for this embodiment as being "*implanted or diffused*" to the first material instead of "*joined*" (support can be found in paragraphs [0036]-[0037]; FIGs. 1, 3 and 6C - 6F).

Claim 6. Independent Claim 6 further recites "*said first material having at least an upper portion doped with a first impurity said first material having at least an upper portion doped with a first impurity*". Support is found in the specification in paragraphs [0029] and [0031] as well as in FIG. 6A.

Claim 11. Independent Claim 11 further recites "*wherein an upper portion of said first semiconductor material has been doped with a different type doping than that of the substrate*", support for which is found in the specification, including FIG. 1, FIG. 3, FIG. 6A- 6F, as well as paragraph [0029].

Claim 16. Independent Claim 16 further recites the substrate having "*a first donor impurity type*" and the first material "*doped with a second impurity type*". The discussion of the *p*-type substrate and *n*-doping of the first material is described in the specification including paragraphs [0024], [0029] and [0031].

Claim 21. Independent Claim 21 further recites the use of the "*different type doping than that of the substrate*", as recited in Claim 11. In addition, Claim 21 recites: "*a doped polysilicon region in contact with one or more sidewalls of said first and/or second material and configured for receiving electrical contacts*", support for which is found throughout the specification including FIG. 1 - 3, FIG. 6E - 6F, and paragraphs [0039] - [0040].

Claim 26. Independent Claim 26 further recites "*wherein said first material comprises a portion of said substrate which remains after adjacent portions of substrate* *material have been etched away*", support for which includes FIG. 1, FIG. 6A, and paragraphs [0029] - [0031].

Claim 31. Independent Claim 31 further recites the layers used in the embodiment of FIG. 1 and FIG. 6A - 6F, specifically:

"*at least one stopper region formed on the upper portion of said substrate around said hill;*

at least one isolation region formed over said at least one stopper region; and

at least two polysilicon regions formed over said isolation regions and in contact with said first and second materials;

said polysilicon regions being configured for receiving contacts for establishing electrical connection to said bipolar junction".

These regions provide numerous benefits as outlined in the specification, such as described as per paragraphs [0031], [0034], and [0039] - [0040].

Claims 22 and 32. Dependent Claims 22 and 32 were amended to clarify how the electrical contacts are established. It can be seen in FIG. 1, FIG. 3 and FIG. 6E - 6F that the electrical contacts can be established in different ways. For example the base contact 26 in FIG. 1 is shown coupled directly to the second material implanted or diffused in the upper surface of the first material area, while the collector 24 and emitter 28 connections are established through doped polysilicon regions 22a, 22b. Support is also found in the text of the specification, including paragraphs [0040] - [0042].

Claims 24, 28 and 33. Dependent Claims 24, 28 and 33 were amended to recite the types of junctions which could be made between *p*-type material, *n*-type material, and *i*-type intrinsic material. These aspects were already claimed but some consolidation of the claims was performed, while claim 33 previously had not recited each of these types.

Claims 25 and 29-30. The material of dependent Claims 25 and 29-30 were combined into prior claims 24 and 28 respectively, and these claims cancelled to reduce the need for additional claim fees.

4. Amendments Made Without Prejudice or Estoppel.

Notwithstanding the amendments made and accompanying traversing remarks provided above, Applicants have made these amendments in order expedite allowance of the currently pending subject matter. However, Applicants do not acquiesce in the original ground for rejection with respect to the original form of these claims. These amendments have been made without any prejudice, waiver, or estoppel, and without forfeiture or dedication to the public, with respect to the original subject matter of the claims as originally filed or in their form immediately preceding these amendments. Applicants reserve the right to pursue the original scope of these claims in the future, such as through continuation practice for example.

5. Addition of Claims 92-118. Dependent Claims 92-118 were added to the invention to clarify or specify additional aspects of the independent claims.

Claims 92, 96, 100, 105 and 109. Dependent Claims 92, 96, 100, 105 and 109 depend respectively from a portion of the independent claims in the application, and describe the position of the second material in the first material, according to the embodiments shown in FIG. 1, FIG. 3 and FIG. 6C-6F. Specifically, it is seen that adjoining surfaces near the corner of the first material are implanted or diffused with another dopant. The process of diffusing or implanting the second material is described in paragraphs [0024] - [0025] and [0037] - [0039] using a tilting process. The figures illustrate the blocking of portions of the top and sidewalls by layers 20b and 60 during the doping process. It should be noted that amended independent Claims 26 and 31 contain the language of these dependent claims within the body of the independent claim.

Claims 93, 97, 107, 110-113 and 117. The inclusion of one or more of the stopper regions, isolation regions and polysilicon contact regions shown in the figures (FIG. 1, FIG. 3, FIG. 6A - 6F) and discussed in the specification are described. The use of a stopper is shown in FIG. 1, FIG. 6A-6F elements 14a, 14b, and is described in the specification, including paragraphs [0024] and [0031]. Inclusion of isolation regions is mentioned in withdrawn Claim 34, and is shown in FIG. 1, FIG. 6A-6F elements 20a, 20b, and described in paragraphs [0034] - [0035]. The polysilicon regions are illustrated in FIG. 1 - FIG. 3, FIG. 6F elements 76a, 76b, and described in the specification including paragraphs [0039] - [0041].

Claims 94, 98, 102, 108, and 114. Dependent Claims 94, 98, 102, 108, and 114 describe the substrate as comprising silicon or silicon-on-insulator. Support for this is found in the specification, including paragraph [0048].

Claims 95, 99 and 103. Dependent Claims 95, 99 and 103 recite forming the first material from a portion of the substrate, which is an embodiment described with regard to FIG. 6A - 6F. This configuration was also described with regard to amended independent Claim 26, and include specification paragraphs [0029] - [0031].

Claim 104. Dependent Claim 104 describes the specific device shown in FIG. 1, with a p-type substrate, n-doped upper portion of the first material and p-type dopant as the second material. Support for this is illustrated in FIG. 1 - 3, FIG. 6A - 6F as well as in the specification including paragraphs [0029], [0031], and [0037] - [0038].

Claim 106. Dependent Claim 106 recites the types of dopants with greater clarity as being either of a *p*-type or an *n*-type. Support being found throughout the specification including paragraphs [0029], [0031], [0037] - [0039] and [0050], as well as being known to those in the art.

Claim 118. Dependent Claim 118 describes the inclusion of passivation regions surrounding the electrical contacts. Support is illustrated in FIG. 1 with a plurality of passivation elements 30, as well as described in the specification, including paragraphs [0024], [0040] and [0043].

6. No Additional Claim fees.

No additional Claim fees are required for the addition of Claims 92-118. The number of independent claims and the total number of claims are less than originally paid for by Applicant.

7. Extension of time under 37 CFR 1.136(a).

A petition is enclosed for a one (1) month extension as described in 37 CFR 1.136(a); an appropriate fee is enclosed.

8. Conclusion.

Based on the foregoing, Applicants respectfully request that the various grounds for rejection in the Office Action be reconsidered and withdrawn with respect to the presently amended form of the claims, and that a Notice of Allowance be issued for the present application to pass to issuance.

In the event any further matters remain at issue with respect to the present application, Applicants respectfully request that the Examiner please contact the undersigned below at the telephone number indicated in order to discuss such matter prior to the next action on the merits of this application.

Date: 9/16/05

Respectfully submitted,

John P. O'Banion, Reg. No. 33,201
O'BANION & RITCHEY LLP
400 Capitol Mall, Suite 1550
Sacramento, CA 95814
(916) 498-1010